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CONTRACT NO. DE-AC05-88OR21548

POST-REMEDIAL ACTION REPORT FOR THE FROG POND DRAINAGE OUTLET (WP-519/505F)

WELDON SPRING SITE REMEDIAL ACTION PROJECT
WELDON SPRING, MISSOURI

JULY 2000

REV. 0



U.S. Department of Energy
Oak Ridge Operations Office
Weldon Spring Site Remedial Action Project

Prepared by MK-Ferguson Company and Jacobs Engineering Group


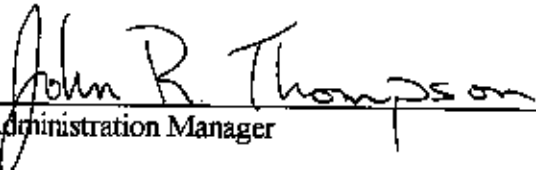
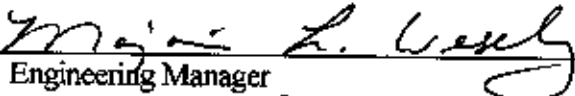





Weldon Spring Site Remedial Action Project
Contract No. DE-AC05-86OR21548

Rev. No. 0

PLAN TITLE: Post-Remedial Action Report for the Frog Pond Drainage Outlet (WP-519/505F)

APPROVALS

	<u>6/30/00</u>
Environmental Safety and Health Manager	Date
	<u>6/29/00</u>
Data Administration Manager	Date
	<u>7-6-2000</u>
Engineering Manager	Date
	<u>7 July 00</u>
Quarry Water Treatment Group Manager	Date
	<u>7/11/2000</u>
Project Quality Manager	Date
	<u>7/11/00</u>
Deputy Project Director	Date

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(WP-519/505F)

Revision 0

July 2000

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U.S. DEPARTMENT OF ENERGY
Oak Ridge Operations Office
Under Contract DE-AC05-86OR21548

ABSTRACT

Contaminated soil removal was conducted in the Frog Pond Drainage Outlet as part of WP-519/505F to remediate the area within the drainage work zone. Surface water originating from the uranium feed materials plant proper deposited contaminated suspended sediments in the Frog Pond Drainage Outlet area. The objective of the remedial action was to ensure that contaminated areas within the WP-519/505F work zone were remediated and met the cleanup standards as stated in the *Record of Decision for Remedial Action at the Chemical Plant Area of the Weldon Spring Site* (ROD). Contaminants of concern (COCs) were chosen for WP-519/505F based upon characterization soil sample results. COCs identified for the Frog Pond Drainage Outlet include Thorium-230 (Th-230) and Uranium-238 (U-238). Remedial activities for WP-519/505F include the excavation of contaminated soil, radiological walkover surveying, and confirmation soil sampling.

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1. INTRODUCTION

1.1 Purpose

This report details the confirmation field activities and analytical results for the contaminated soil removal of the Frog Pond Drainage Outlet (WP-519/505F) on the August A. Busch Conservation Area. Past activities of the Atomic Energy Commission within the Weldon Spring Site Remedial Action Project (WSSRAP) area led to contamination of on-site soils that were ultimately deposited in the Frog Pond Drainage Outlet area.

Soil characterization, along with the pre-excavation walkovers of the WP-519/505F work zone, determined that the work zone contained contaminated concentrations that exceeded the cleanup criteria levels established in the *Record of Decision for Remedial Action at the Chemical Plant Area of the Weldon Spring Site (ROD)* (Ref. 1). The work zone, covering approximately 0.15 acres, was designated as remedial unit (RU) 27, confirmation unit (CU) 390. Confirmation of soil to the ROD cleanup standards was required.

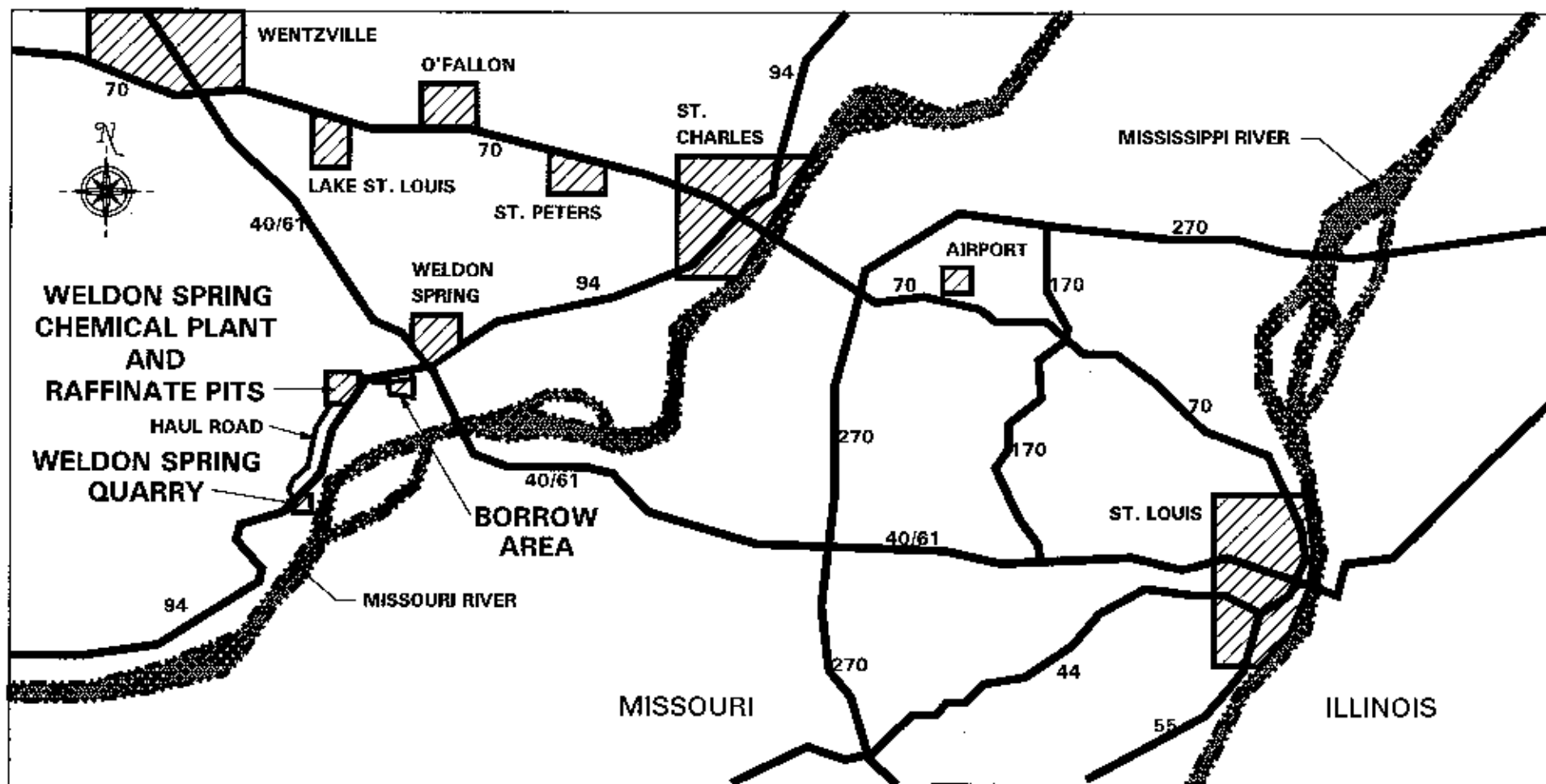
1.2 Scope

This report describes only the remedial activities and confirmation survey/sampling conducted on radiological contaminated soils within RU27. Confirmation walkovers and soil sampling were conducted in accordance with the *Confirmation Sampling Plan Details for the Frog Pond Drainage Outlet (WP-519/505F)* (Ref. 2). This plan was developed to ensure that the *Chemical Plant Area Cleanup Attainment Confirmation Plan* (Ref. 3) objectives were accomplished, and to ensure established remediation requirements of the ROD were met.

1.3 Site Description and History

The WSSRAP is located in St. Charles County, Missouri, about 48 km (30 mi) from St. Louis, on land formerly used by the U.S. Department of the Army (Army) as a trinitrotoluene (TNT) and dinitrotoluene (DNT) ordnance works (Figure 1-1). The 88-ha (217 acre) chemical plant area is located about 3.2 km (2 mi) southwest of the junction of Missouri State Route 94 and U.S. Route 40/61. The site is accessible from Missouri State Route 94, and is fenced and closed to the public.

The two communities closest to the site, Weldon Spring and Weldon Spring Heights are located approximately 3.2 km (2 mi) east of the site and have a combined population of 850 persons. Francis Howell High School is located about 1 km (0.6 mi) from the site on the eastern side.



LOCATION OF THE WELDON SPRING SITE

FIGURE 1-1

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In 1941, the Army acquired 7,000 ha (17,000 acres) of land in St. Charles County, Missouri. The Army constructed an ordnance facility and produced DNT and TNT explosives from 1941 until 1946. By 1949, all but 810 ha (2,000 acres) were transferred to the State of Missouri and the University of Missouri. Most of the remaining land became the chemical plant area of the Weldon Spring site and the adjacent U.S. Army Reserve and National Guard training area.

In May 1955, the U.S. Atomic Energy Commission (AEC) acquired 83 ha (205 acres) to construct a uranium feed materials plant. The AEC operated the uranium feed materials plant from 1957 to 1966 within the WSSRAP area. During its operation, uranium and thorium ore concentrates were processed, which led to on-site contamination of soils. Radioactive and chemical wastes were disposed of at the site during this period. The radioactive contaminants associated with the site are primarily radionuclides of the natural uranium and Th-232 decay series. Chemical contaminants associated with the site are primarily heavy metals, polychlorinated biphenyls (PCBs), and polynuclear aromatic hydrocarbons (PAHs).

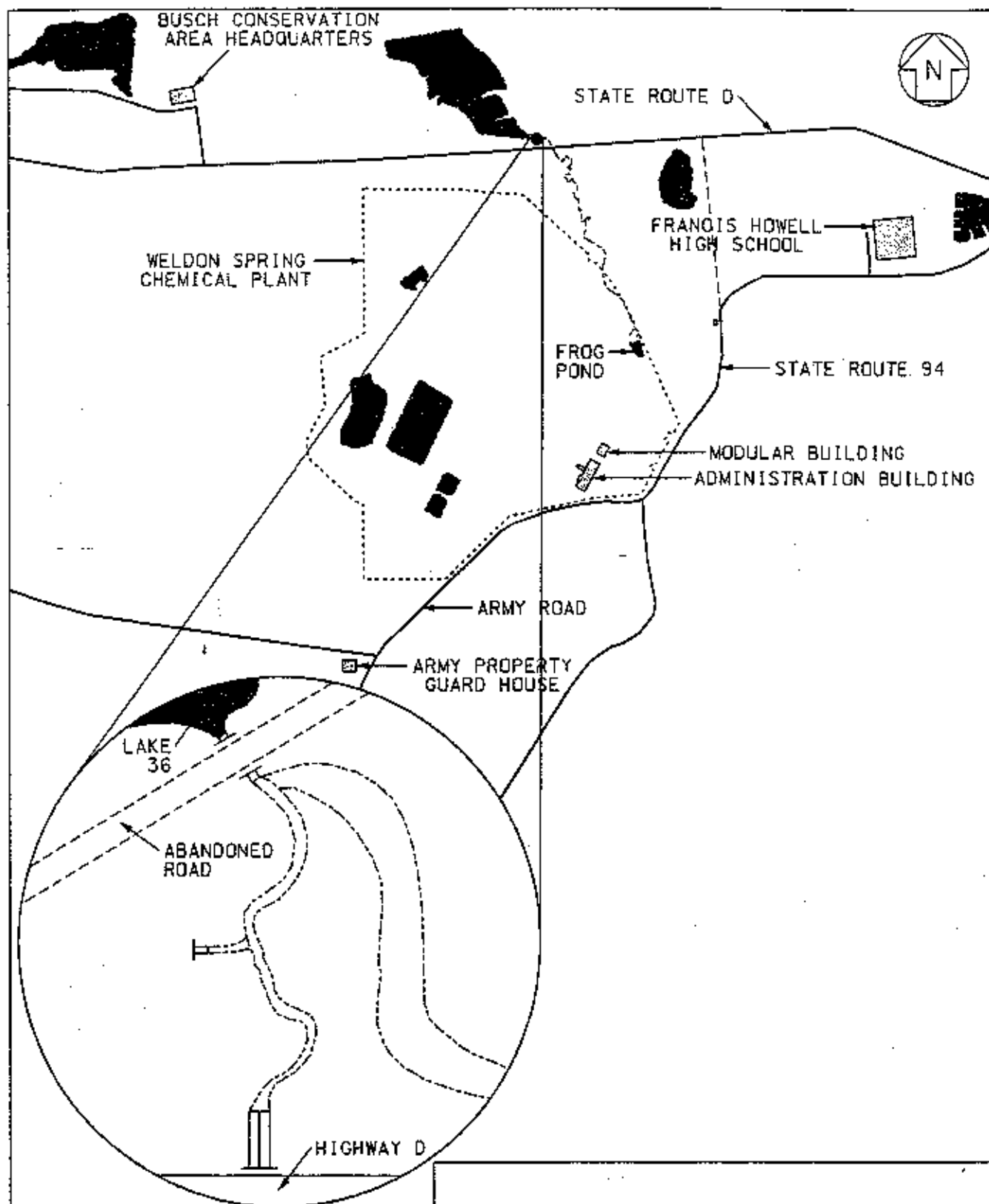
The Army reacquired the chemical plant property in 1967 and began decontamination and dismantlement operations in order to construct a herbicide facility. The project was canceled in 1969 before herbicide production was initiated. By 1985, the Army had turned responsibility for the site over to the U. S. Department of Energy (DOE), successor to the AEC. In 1986, the DOE initiated a series of interim response actions to control and mitigate releases to the environment. The chemical plant area was included on the National Priorities List (NPL) in 1989, and a ROD was signed in 1993.

The Frog Pond Outlet area is located north of the Weldon Spring Chemical Plant area (Figure 1-1) and south of *August A. Busch Conservation Lake 36*. The general location of the Frog Pond Outlet area is shown on (Figure 1-2).

1.4 Remediation and Confirmation Process

This report details the activities conducted to remediate RU27 (CU390). Remediation consisted of excavation of contaminated soils and debris. Following the remediation activities, walkovers were conducted and confirmation samples were collected to ensure that contaminated materials had been remediated.

The entire remediation process included: characterization sampling, historical data review, COC identification, confirmation plan development, contaminated soil excavation, radiological walkover surveys, confirmation soil sampling, preliminary and final data review, completion of disposition forms, quality assurance/quality control (QA/QC) review, summary of findings and conclusions, and closure report preparation.



LOCATION OF FROG POND
DRAINAGE OUTLET AREA

FIGURE 1-2

NOT TO SCALE

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The confirmation sampling process in the Frog Pond Drainage Outlet was conducted in accordance with the *Chemical Plant Area Cleanup Attainment Confirmation Plan* (Ref. 3), to attain cleanup goals set forth in the ROD. The walkover and sampling details are presented in the *Confirmation Sampling Details for the Frog Pond Drainage Outlet (WP-519/505F)* (Ref. 2).

2. PRE-REMEDIATION ACTIVITIES

2.1 Review of Characterization Data and Historical Information

Contaminants of concern (COC) for confirmation were determined by reviewing soil characterization data. Review of historical information revealed that surface water carried contaminated suspended soils to the Frog Pond drainage, with the depositional material accumulating at the lowermost end of the drainage. Characterization data showed Th-230 and U-238 were present in soil samples at concentrations exceeding criteria in the outlet area (Ref. 10).

2.2 Contaminants of Concern

Radiological COCs identified for CU390 are Th-230 and U-238. No chemical COCs were identified.

2.3 Data Quality Objectives

Data Quality Objectives (DQOs) were identified to specify and ensure that quality data would be sufficient to support the decision making process throughout remedial activities, including the confirmation process. Confirmation DQOs were developed for sampling and analyzing soils during remediation and for the subsequent data evaluation. The DQOs were designed to make statistically defensible decisions regarding attainment of cleanup standards. Sampling and analytical programs for the WP-519/505F area were designed in accordance with DQOs stated in the *Chemical Plant Area Cleanup Attainment Confirmation Plan (Attainment Plan)* (Ref. 3).

2.4 Remediation Guidelines

Remedial work was conducted in the areas containing contaminated soils. Remediation activities for RU27 were conducted in accordance with the guidelines stated in the *Vicinity Property Frog Pond Outlet Remediation* (Ref. 4) specifications. Guidelines were developed for confirmation soil sampling, data evaluation, and Quality Assurance/Quality Control (QA/QC) measures. Remediation guidelines were designed to meet the applicable soils cleanup standards stated in the Record of Decision (ROD) (Ref. 1) and the *Attainment Plan* (Ref. 3).

2.5 Cleanup Standards

The objective of the U.S. Department of Energy (DOE) as low as reasonably achievable (ALARA) process is to reduce exposures and risks associated with residual contamination. The ROD (Ref. 1) established two different sets of cleanup standards: risk-based cleanup criteria and ALARA goals. Remedial activities for WP-519/505F were designed to remove soil where the

COC concentration is present above ALARA goals. Table 2-1 summarizes the cleanup criteria and ALARA goals established in the ROD that are applicable for COC in the WP-519/505F area.

Throughout the remedial activities at RU27, COC concentrations were evaluated with the ALARA process. The two sets of cleanup standards (ALARA goals and cleanup criteria) were applied at two different stages of the cleanup confirmation process discussed below in Section 2.6.

Table 2-1 ROD Cleanup Standards for COC Within the WP-519/505F Remedial Unit

RADIONUCLIDE (pCi/g)	SURFACE ^(a)		SUBSURFACE ^(b)	
	ALARA (pCi/g)	CRITERIA (pCi/g)	ALARA (pCi/g)	CRITERIA (pCi/g)
Th-230	5.0	6.2	5.0	16.2
U-238	30.0	120.0	30.0	120.0

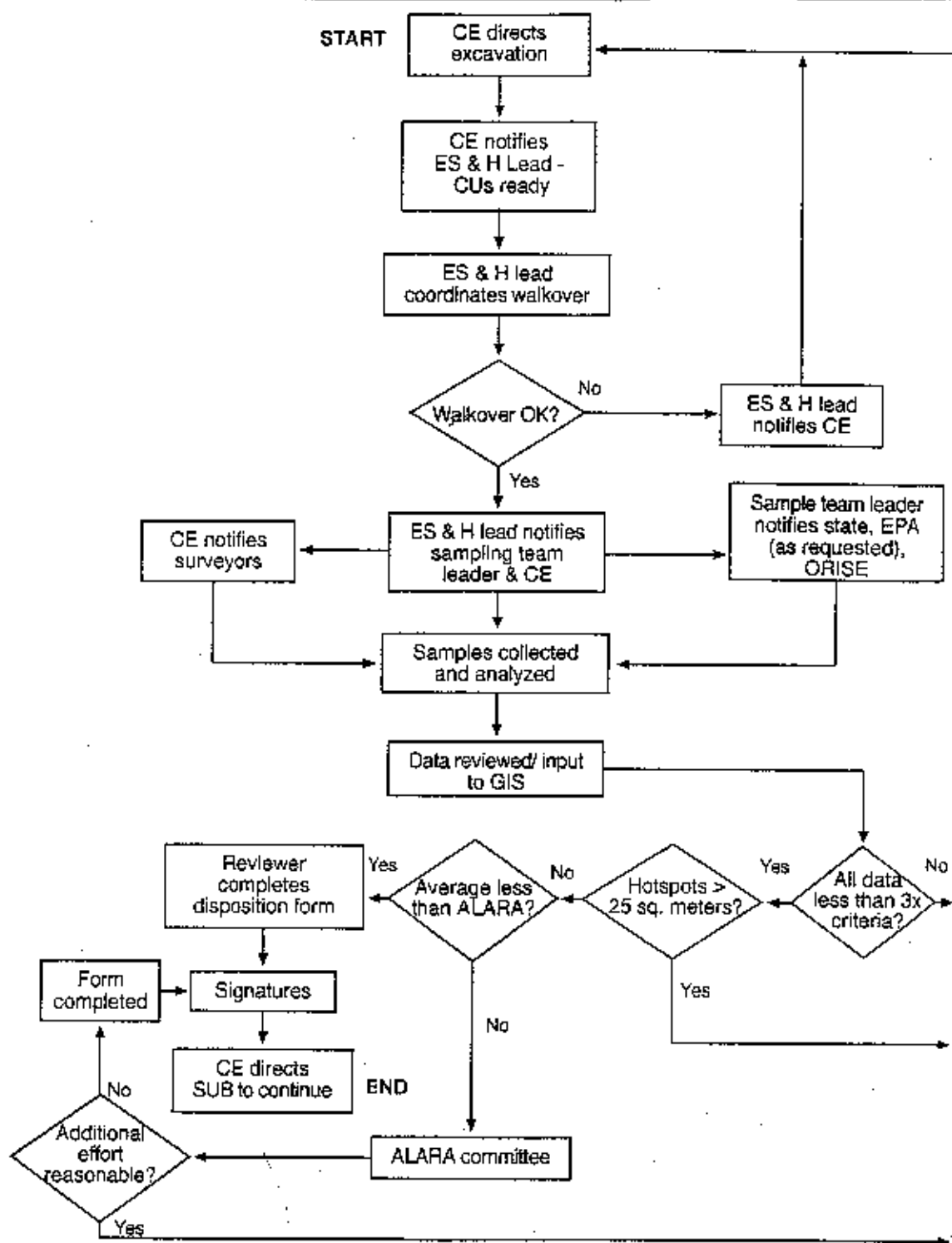
(a) Values listed for surface soils apply to contamination within the upper 15 cm (6 in.) of the soil column.

(b) Values for subsurface apply to contamination in soils below 15 cm (6 in.) unless otherwise noted.

Source: *Record of Decision for Remedial Action at the Chemical Plant Area of the Weldon Spring Site* (Ref. 1)

2.6 Cleanup Confirmation Process

The cleanup confirmation process is used to determine, under the remedial guidelines, if remediation activities have achieved the cleanup standards. Figure 2-1 shows the cleanup confirmation process for remedial activities conducted at the WP-519/505F area. The decision making process was developed to specify how the data will be applied and evaluated within the cleanup confirmation process. The process includes provisions for any hot spots that may be encountered by applying a formula to determine the acceptable size of the hotspot for the COC. No hot spots were encountered during confirmation of this confirmation unit (CU).



CLEANUP CONFIRMATION PROCESS

FIGURE 2-1

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3. REMEDIAL ACTIVITIES

3.1 Excavation Activities

Contaminated soils and other debris from the Frog Pond Drainage Outlet area were first excavated to the design depth of 7 ft., as detailed in the specifications. After the initial excavation was complete, radiological walkover surveys were conducted to evaluate the need for additional excavation. The area within RU27 was released for confirmation sampling once the radiological walkover surveys or other appropriate decisions indicated that no additional excavation was needed.

The elevated readings found during walkover surveys on the side walls indicated additional action was necessary. Contaminated material was excavated or "chased" into the side walls of the excavation. The additional excavations were outside the scope of the WP-519/505F contract. The original CU390 boundaries were extended and a modification to the subcontract was made before additional excavation into the side walls of the original excavation was performed. Two specific areas requiring further excavation were limited by the location of existing features. The first area involves two 60-in. culverts running beneath County Highway D and exiting into the Frog Pond Outlet. The second area involves a 42-in. culvert in the northwest portion of the excavation, leading into the August A. Busch Conservation Area Lake 36 (Lake 36).

In the first of these two areas, a decision was made to further evaluate the soil beneath the two culverts. *Addendum 6 to the Engineering Soils Sampling Plan For Army and MDC Vicinity Properties* (Ref. 5) describes the method used for the additional characterization sampling beneath the culverts. Results from the characterization sampling efforts are listed in Table 3-1 and additional details can be found in the *Closure Report for Soil Sampling at the Frog Pond Outlet, Addendum 6 of the Engineering Soil Sampling Plan for Army and MDC Vicinity Properties* (Ref. 9). As indicated in Table 3-1, results of some contaminants of concern (COC) in soil beneath the culverts were greater than criteria. Contamination was chased and approximately 20 linear feet of pipeline and surrounding soils were removed until the excavation approached Highway D. In order to avoid disturbance of a nearby fiber optics line and the highway itself, a decision was made between the Primary Management Contractor (PMC) and the Department of Energy (DOE) to cease excavation activities, concrete in two new culvert extensions, backfill, and leave them in place.

A risk assessment was done by Argonne National Laboratory using the results presented in Table 3-1. The risk estimates indicated that exposure to the residual contaminant levels at the culvert area would result in a very low potential risk to an industrial worker or recreational visitor (10^{-6} or lower). In addition, an ALARA committee meeting was held to discuss the soil remaining beneath the culverts at Highway D. Based upon

Table 3-1 Results of Characterization Samples Beneath Frog Pond Outlet 60-In. Culverts

Frog Pond Outlet 60-In. Culvert	Sample ID #	Parameter	Concentration (pCi/g)	Surface ALARA (pCi/g)	Subsurface Criteria* (pCi/g)	Greater Than ALARA (pCi/g)	Greater Than Criteria (pCi/g)
Eastern-most Culvert (left)	SO-499010-01	Ra-226	1.18	5.0	16.2	NO	NO
		Ra-228	ND	5.0	16.2	NO	NO
		Th-230	6.44	5.0	16.2	YES	NO
		U-238	310	30.0	120.0	YES	YES
Western-most Culvert (right)	SO-499011-01	Ra-226	0.82	5.0	16.2	NO	NO
		Ra-228	1.02	5.0	16.2	NO	NO
		Th-230	3.30	5.0	16.2	NO	NO
		U-238	48.4	30.0	120.0	YES	NO

* Subsurface levels were used because the area was entombed with concrete and then backfilled.

the information presented, which included the risk assessment results, the presence of obstacles such as Highway D and fiber optic lines, and the conclusion that the area remaining met the hotspot rule based upon conservative assumptions, it was agreed that this area should remain without additional remediation.

In the second area requiring further evaluation, a 42 in. culvert running from the Frog Pond Drainage Outlet to Lake 36 was considered. Chasing contamination along the culvert in the northwest portion of the excavation extended the excavation towards the west berm of Lake 36. Excavation continued approximately 8 ft into the lake bed while the integrity of the berm was continuously maintained to prevent lake water from flowing into the excavation. A decision was made by the PMC to discontinue chasing contamination along the lake bed. The excavation was backfilled with clay material to act as a dam, and the area was re-characterized at a later date. The *Sampling Plan for Radiological Characterization of Sediments and Soil Within the Southeast Corner of Busch Lake 36* (Ref. 6) details the method used for additional characterization sampling at Lake 36. Results of this sampling activity revealed that none of the 106 samples taken exceeded the 30 pCi/g U-238 ALARA level. Specific details of this sampling activity may be referenced in the *Closure Report for Radiological Characterization of Sediments and Soil Within the Southwest Corner of Busch Lake 36 Sampling Plan* (Ref. 10).

3.2 Contaminated Waste Management

All materials excavated during remediation activities and prior to confirmation were removed as contaminated. These contaminated materials were placed into the on-site disposal cell facility.

3.3 Field Activities

Field activities completed during remedial activities, such as walkover surveys and soil sampling, were conducted in accordance with procedures as stated in the *Confirmation Sampling Plan Details for the Frog Pond Drainage Outlet (WP-519/505F)* (Ref. 2). All remedial action surveys and sampling were conducted and documented in accordance with Weldon Spring Site Remedial Action Project (WSSRAP) Environmental Safety and Health (ES&H) procedures. A listing of applicable procedures is provided in (Section 7).

3.3.1 Walkover Surveys

Radiological walkover surveys were conducted during remedial activities to aid excavation and again prior to confirmation soil sample collection. Walkover surveys were conducted using a 2 in. x 2 in. NaI scintillation detector. The radiological walkover survey readings were within an acceptable range (less than 1.5 times background) on the floor of the excavation. Elevated readings were found on the side walls of the excavation as discussed in Section 3.1. Radiation survey field sheets are presented in (Appendix C).

3.3.2 Confirmation Sampling

Once the walkovers were completed, soil sampling was conducted as part of the confirmation process. The 11 sampling locations for CU390 are shown on Figure 3-1. This CU was sampled during September 1999.

All COC preliminary concentrations were below the respective as low as reasonably achievable (ALARA) goals. The average concentration for CU390 remained below the ALARA goals.

After the preliminary data were reviewed, disposition forms (Appendix B) were completed and signed. Based on the preliminary confirmation data, CU390 was released for unrestricted use.

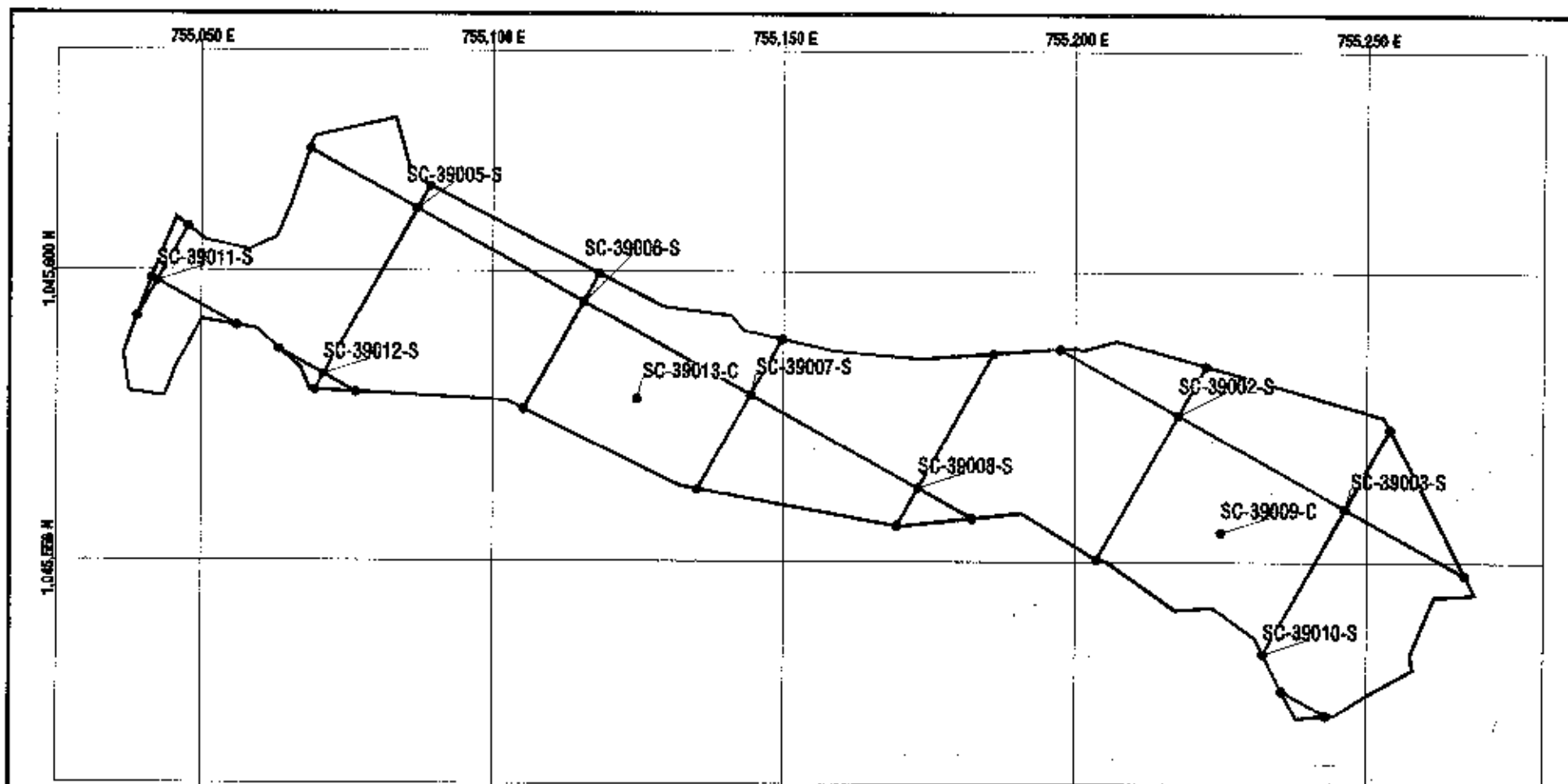
Upon receipt of the data packages, the final data were reviewed and compared to the preliminary data. Note that the preliminary data are the initial results available immediately from the laboratory and are subject to change. Final data are the fully reviewed results of the analyses performed. The final analytical results agree with the preliminary results and indicate that the remedial activities have been completed. The final results meet the cleanup standards as detailed in the *Chemical Plant Area Cleanup Attainment Confirmation Plan* (Ref. 3) for CU390. A summary of the final results for CU390 is presented in Table 3-2. This table provides the number of samples, range, and average for the COCs associated with CU390. A complete list of the final analytical data and coordinates for CU390 are provided in Appendix C.

Table 3-2 Summary of Analytical Results for RU27, CU390 in WP-519/505F

CONTAMINANT	NO. OF SAMPLES	CONCENTRATION RANGE (pCi/g)	AVERAGE CONCENTRATION (pCi/g)	SURFACE ALARA (pCi/g)	SURFACE CRITERIA (pCi/g)	NO. GREATER THAN ALARA	NO. GREATER THAN CRITERIA
Th-230	11	0.78 – 1.14	0.92	5.00	6.20	0	0
U-238	11	1.10 – 5.22	2.00	5.00	6.20	0	0

3.4 Laboratory Activities

All radiological analyses for CU390 were conducted at the on-site laboratory in accordance with *Project Management Contractor Quality Assurance Program* (Ref. 7). Appendixes C and D contain the final analytical results including quality control (QC) for CU390. Radiological analytical data were subject to data evaluation and validation upon receipt from the laboratory. Additional details are provided in Section 4.



10 5 0 METERS

30 15 0 FEET



Sample Locations in Remedial Unit RU027 Confirmation Unit CU300

Figure: 3-1

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4. DATA EVALUATION

Data evaluation was performed on WP-519/505F analytical data to determine whether data quality objectives developed for the Weldon Spring Site Remedial Action Project (WSSRAP) were met and to ensure overall data quality results generated from RU27 remedial activities were presented. Data evaluation was performed in accordance with the *Project Management Contractor Quality Assurance Program* (Ref. 7) and the *Environmental Quality Assurance Project Plan* (Ref. 8). The data evaluation process included data verification, data review, data validation, and data management and reduction activities as stated in the *Chemical Plant Area Cleanup Attainment Confirmation Plan* (Ref. 3).

4.1 Data Verification

Data verification was conducted in accordance with ES&H 4.9.1, *Environmental Monitoring Data Verification*, to ensure that documentation and data were reported in compliance with established reporting requirements and standard operating procedures (SOPs), and to ensure that all analyses were performed. All analytical results received from the laboratory were reviewed to verify that samples were properly handled according to WSSRAP protocol. The following factors were reviewed and evaluated: sample identification, chain of custody, holding times, sample preservation requirements, sample analysis request forms, data reviews, laboratory tracking, data reporting requirements, and the database transfer activities.

4.2 Data Review

Data packages were reviewed to ensure the final data were properly identified, analyzed, reported, and met data quality requirements (DQRs). The data were also reviewed to check for inconsistencies with the field quality control (QC) samples. Final analytical results were also compared to the preliminary analytical results to identify any changes in data.

During confirmation of WP519/505F, soil samples were obtained in accordance with the details provided in the sampling plan (Ref. 9). The plan indicates that quality control samples were to be taken at a frequency of 1 per 20 samples or 5%. The quality control samples collected during this event include secondary duplicates and field replicates.

Table 4-1 provides a summary of QC samples collected during WP519/505F confirmation activities. A complete listing of QC results are in Appendix D. All of the QC samples met the 5% frequency requirement for radiological samples.

Table 4-1 Summary of QC Samples

Contaminant	Number of Samples	Number of QC Samples Required	DUPLICATE	FIELD REPLICATE
Th-230	11	1	1	1
U-238	11	1	1	1

The data quality required precision goals for the samples are a relative percent difference (RPD) of no more than 50% and a duplicate error ratio (DER) of less than 1.0

4.3 Duplicates/Field Replicates

Duplicate (DU) samples are aliquots taken from the parent sample at the laboratory. Field replicates (FR) are split in the field from the parent sample. The field replicate is sent to the same laboratory as the parent. The FR and DU results are compared to the parent sample and the RPD is calculated for each. The recommended RPD for radiological parameters is less than, or equal to, 50%. RPDs are not calculated when one or both of the results are nondetects. If one or both of the results are less than five times the detection limit, the RPD value is considered of limited value due to higher tolerance limits near the analytical detection limit; therefore, no further analysis is required. In those cases where the RPDs are greater than the recommended limit, the data are further evaluated as discussed below.

Average RPDs for the duplicates and field replicates were within the recommended limits. Duplicate RPDs ranged between 9.84% - 25.28%. Field replicate RPDs ranged between 4.49% - 64.49%. Even though some of the RPDs exceeded the recommended limits, the concentrations were less than five times the detection limits and, therefore, no further analysis was performed. Table 4-2 presents a summary of the results.

Table 4-2 Summary of Duplicate/Field Replicate Samples

Contaminant	Duplicates			Field Replicates		
	RPD*	DER**	Percentage of samples meeting the accuracy requirements	RPD*	DER**	Percentage of samples meeting the accuracy requirements
Th-230	9.84%	0.113	100%	4.49%	0.054	100%
U-238	25.28%	0.176	100%	64.49%	0.399	50%

* RPD = Relative percent difference. Value should be less than 50%.

** DER = Duplicate error ratio. Value should be less than 1.

4.4 Data Validation

Data validation is performed on 10% of all analytical data generated from the confirmation sampling activities at the WSSRAP and is conducted in accordance with ES&H 4.9.2, *Environmental Monitoring Data Validation*. No data associated with RU27 were rejected during validation.

5. SUMMARY OF CLOSURE REPORT FINDINGS

The total Work Package (WP)-519/505F area consists of one confirmation unit (CU) contained within remedial unit (RU) 27. Detailed information regarding the remedial activities for CU390, including disposition forms, final data, and walkover forms is presented in the Appendixes.

5.1 Data Validation

Upon completion of remediation activities, preliminary results were used to complete CU Disposition Forms in accordance with ES&H 1.2.1, *Soil Remediation Disposition Process*. Disposition forms were reviewed and signed off by the designated project personnel. The CU was released when all the contaminants of concern (COC) concentrations located within the CU were in compliance with the *Record of Decision* (ROD) cleanup standards (Ref. 1). Based on the preliminary results, the CU was released for unrestricted use on September 10, 1999.

5.2 Summary of WP-519/505F Confirmation Results

Table 5-1 provides a summary of the total number of samples collected and analyzed for each contaminant during remedial activities conducted under WP519/505F. The number of detections that exceed as low as reasonably achievable (ALARA) and minimum, maximum, and average concentrations are also provided for each contaminant. The table was generated using data sets compiled from all samples that represented soils left in place.

Table 5-1 Summary Totals for RU27, CU390

CONTAMINANT	NO. OF SAMPLES	MINIMUM CONCENTRATION (pCi/g)	MAXIMUM CONCENTRATION (pCi/g)	AVERAGE CONCENTRATION (pCi/g)	SAMPLES GREATER THAN ALARA
Th-230	11	0.78	1.14	0.92	0
U-238	11	1.10	5.22	2.00	0

Analytical results generated from the remedial activities at RU27 indicate the average concentration of each COC over the entire RU27 area is below the ALARA goal. COC averages were also calculated and are below ALARA. All 100 m² averages were less than criteria.

5.3 Summary of Confirmation Results

To meet the requirements of the Record of Decision (Ref. 1), more than 50% of the results for each parameter must be less than the ALARA goal. Table 5-2 summarizes the cumulative results to date.

Table 5-2 Summary Totals for Confirmation

CONTAMINANT	NO. OF SAMPLES	MINIMUM CONCENTRATION	MAXIMUM CONCENTRATION	AVERAGE CONCENTRATION	RESULTS> ALARA
Arsenic (mg/kg)	856	0.48	34.10	7.43	0
Chromium (mg/kg)	1,276	3.80	41.60	17.12	0
Lead (mg/kg)	995	2.40	817.00	17.06	2
PAH (mg/kg)	582	ND	4.53	0.19	68
PCB (mg/kg)	1,438	ND	6.00	0.04	20
Ra-226 (pCi/g)	2,133	0.33	9.43	1.34	3
Ra-228 (pCi/g)	1,942	0.30	6.60	1.27	2
Thallium (mg/kg)	248	0.12	5.20	1.14	0
Th-230 (pCi/g)	1,624	0.09	23.10	1.60	30
Th-232 (pCi/g)	1,848	0.31	6.77	1.30	2
TNT (mg/kg)	77	ND	34.00	0.93	1
U-238 (pCi/g)	3,476	0.39	228.00	3.89	44

5.4 Comparison of Standard Deviations

This section provides a comparison of the estimated standard deviations calculated following U. S. Environmental Protection Agency (EPA) guidance and presented in the *Attainment Plan* (Ref. 3), with those deviations calculated using confirmation results. Since there were no existing remediation data available to calculate the standard deviation (sigma), the *Attainment Plan* (Ref. 3) estimated sigma using the range (assuming the average concentration remaining after remediation would not exceed cleanup criteria) divided by six. To determine whether the specified level of precision was obtained, a comparison was made between the estimated sigma and the calculated sigma using the RU27 results.

The comparison indicates that the specified level of precision (a false positive = 0.05 and a false negative = 0.20) has been obtained. All of the calculations are less than estimated sigmas, indicating that the minimum specified precision was met. Table 5-3 presents the estimated sigma and calculated sigmas for each COC.

Table 5-3 Comparison of Standard Deviations

CONTAMINANT	ESTIMATED SIGMA ^(a)	RU27 SIGMA ^(b)	CUMULATIVE SIGMA ^(c)
Arsenic (mg/kg)	12.5	NS	3.57
Chromium (mg/kg)	16.3	NS	5.01
Lead (mg/kg)	75	NS	30.66
PAH (mg/kg)	0.93	NS	0.50
PCB (mg/kg)	1.33	NS	0.30
Ra-226 (pCi/g)	1.03	NS	0.37
Ra-228 (pCi/g)	1.03	NS	0.36
Thallium (mg/kg)	3.3	NS	1.18
Th-230 (pCi/g)	1.03	0.11	1.43
Th-232 (pCi/g)	1.03	NS	0.38
TNT (mg/kg)	23.3	NS	4.27
U-238 (pCi/g)	20	1.27	9.10

(a) Sigma estimated in the *Attainment Plan* (Ref. 3).

(b) Sigma calculated using only the WP-519/505F confirmation results.

(c) Sigma calculated using cumulative confirmation results. Results from the four partial CUs confirmed located within RU21 are not included in this table with the WP-471 results. They will be included in the RU21 results table when the CUs are completed under WP-437.

NS Not Sampled.

6. REFERENCES

1. Department of Energy. *Record of Decision for Remedial Action at the Chemical Plant Area of the Weldon Spring Site*. Rev. 0. DOE/OR/21548-376. Oak Ridge Field Office. St. Charles, MO. September 1993.
2. MK-Ferguson and Jacobs Engineering Group. *Confirmation Sampling Plan Details for the Frog Pond Drainage Outlet (WP519/505F)*, Rev. 0. DOE/OR/21548-779. Prepared for the U.S. Department of Energy, Oak Ridge Field Office. St. Charles, MO. March 1999.
3. MK-Ferguson and Jacobs Engineering Group. *Chemical Plant Area Cleanup Attainment Confirmation Plan*, Rev. 3. DOE/OR/21548-491. Prepared for the U.S. Department of Energy, Oak Ridge Field Office. St. Charles, MO. December 1995.
4. MK-Ferguson Company and Jacobs Engineering Group. *Engineering Soils Sampling Plan for Army and MDC Vicinity Properties: Addendum 4: Soil Sampling At Frog Pond Drainage Outlet And MDC-6*. Rev. 1. DOE/OR/21548-622. Prepared for the U.S. Department of Energy, Oak Ridge Operations Office. St. Charles, MO. October 1998.
5. MK-Ferguson Company and Jacobs Engineering Group. *Engineering Soils Sampling Plan for Army and MDC Vicinity Properties: Addendum 6: Engineering Characterization Sampling At Frog Pond Outlet (Soil Beneath Twin 60-Inch Culverts)*. Rev. 0. DOE/OR/21548-622. Prepared for the U.S. Department of Energy, Oak Ridge Operations Office. St. Charles, MO. April 1999.
6. MK-Ferguson Company and Jacobs Engineering Group. *Sampling Plan for Radiological Characterization of Sediments and Soil Within the Southeast Corner of Busch Lake 36*. Rev. 0. DOE/OR/21548-827. Prepared for the U.S. Department of Energy, Oak Ridge Operations Office. St. Charles, MO. November 1999.
7. MK-Ferguson Company and Jacobs Engineering Group. *Project Management Contractor Quality Assurance Program*. Rev. 5. DOE/OR/21548-333. Prepared for the U.S. Department of Energy, Oak Ridge Operations Office. St. Charles, MO. July 1999.
8. MK-Ferguson and Jacobs Engineering Group. *Environmental Quality Assurance Project Plan*, Rev. 4. DOE/OR/21548-352. Prepared for the U.S. Department of Energy, Oak Ridge Field Office. St. Charles, MO. October 1999.

9. MK-Ferguson Company and Jacobs Engineering Group. *Closure Report for Soil Sampling at the Frog Pond Outlet, Addendum 6 of the Engineering Soil Sampling Plan for Army and MDC Vicinity Properties*. Rev. 0. DOE/OR/21548-829. Prepared for the U.S. Department of Energy, Oak Ridge Operations Office. St. Charles, MO. January 2000.
10. MK-Ferguson Company and Jacobs Engineering Group. *Closure Report for the Radiological Characterization of Sediments and Soil Within the Southeast Corner of Busch Lake 36 Sampling Plan*. Rev. 0. DOE/OR/21548-835. Prepared for the U.S. Department of Energy, Oak Ridge Operations Office. St. Charles, MO. March 2000.

PROCEDURES

- ES&H 1.2.1, *Soil Remediation Disposition Process*.
- ES&H 2.3.8, *Contamination Survey*
- ES&H 2.4.1, *Calibration and Use of Portable Radiological Survey Instruments*
- ES&H 2.5.5, *Sample Preparation Procedure for Radiological Soil Samples*
- ES&H 2.5.8, *Th-230 Determinations in Soils by the UNC Method*
- ES&H 2.6.9, *Instructions for Calibration and Operation of the High Purity Germanium Detector*
- ES&H 4.1.3, *Sample Equipment Decontamination*
- ES&H 4.4.1, *QC Samples for Aqueous and Solid Matrices*
- ES&H 4.4.5, *Soil/Sediment Sampling*
- ES&H 4.9.1, *Environmental Monitoring Data Verification*
- ES&H 4.9.2, *Environmental Monitoring Data Validation*

APPENDIX A
Disposition Forms

SOIL CONFIRMATION REMEDIATION DISPOSITION FORM

Page 1 of 2

SECTION I

1. Work Package Number: 519 2. Date: 9/10/99 3. Review Form #: 99-087
4. Remediation Unit Number: 027 5. Confirmation Unit Number: 390 (map attached)
6. ☒ Full CU release ☐ Partial CU release 7. Applicable Cleanup Standards: ☒ Surface ☐ Subsurface
8. Contaminants of Concern: ☒ U-238 ☒ Th-230 ☐ Th-232 ☐ Ra-226 ☐ Ra-228
☐ TNT ☐ PCB ☐ PAH ☐ As ☐ Cr ☐ Pb ☐ Tl

9. Results average below ALARA goal(s)? ☒ Yes ☐ No

10. All results below cleanup criteria? ☒ Yes ☐ No

11. Hot spots present that comply with the Attainment Plan? ☐ Yes ☒ No

Location	Parameter	Size	Concentration

12. Comments

13. Reviewer Disposition Recommendation:
☒ Release for Unrestricted Use (Section II)
☐ ALARA Committee Required (Section III)

14. Reviewer: [Signature] Date: 9/10/99

SECTION II

CU is released for unrestricted use.

15. ES&H Manager: [Signature] Date: 9/10/99

16. DOE Project Manager/Engineer (for full CU Release): Angela Patrick Date: 9-10-99

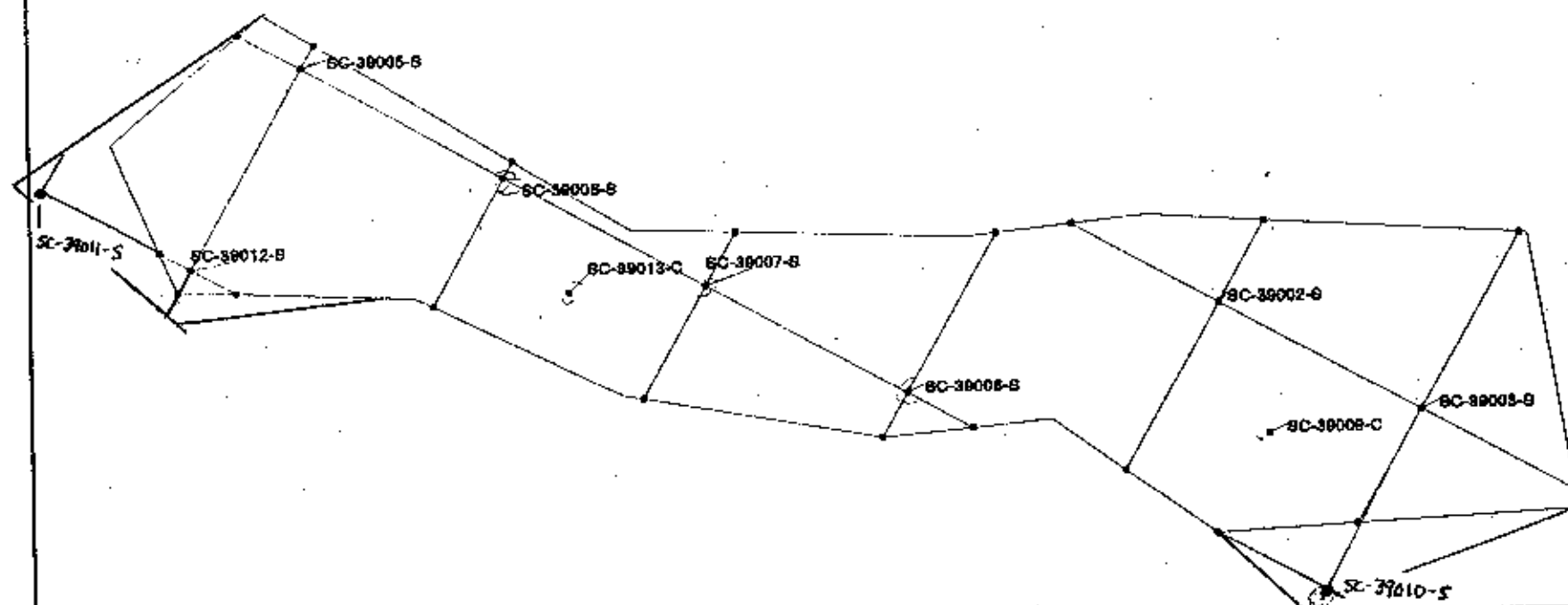
17. Project Manager: [Signature] Date: 10 Sept 99

18. Construction Engineer: [Signature] for B. Fox Date: 10 Sept 99

19. Project Engineer (for subsurface release): [Signature] Date:

SEE ATTACHED RESULTS AND MAP

Full Release of CU390



15 7.5 0 METERS

45 22.5 0 FEET

Sample Locations in Remedial Unit RU027
Confirmation Unit CU390

Figure: 3-2

EXHIBIT NO.: G/CP/0177/0499	REPORT NO.: DOE/OR/21548-779
ORIGINATOR: EJD	DRAWN BY: WSSRAP GIS DATE: 04/04/89

09/10/99

CUS90 DATA REPORT

THORIUM-230

PARAMETER	LOCATION	CONCENTRATION	DETECTION_LIMIT	UNITS
THORIUM-230	SC-39002-S	0.78	0.64	pCi/g
THORIUM-230	SC-39003-S	1	0.64	pCi/g
THORIUM-230	SC-39005-S	0.87	0.62	pCi/g
THORIUM-230	SC-39006-S	1.14	0.65	pCi/g
THORIUM-230	SC-39007-S	0.86	0.64	pCi/g
THORIUM-230	SC-39008-S	1	0.65	pCi/g
THORIUM-230	SC-39009-C	0.95	0.65	pCi/g
THORIUM-230	SC-39010-S	0.93	0.65	pCi/g
THORIUM-230	SC-39011-S	0.94	0.65	pCi/g
THORIUM-230	SC-39012-S	0.78	0.62	pCi/g
THORIUM-230	SC-39013-C	0.89	0.64	pCi/g

NUMBER OF THORIUM-230 SAMPLES IN DATABASE FOR THIS CU IS: 11

Average of THORIUM-230 values is 0.92 pCi/g, which is below ALARA, 5.00 pCi/g.

Maximum single value is 1.14 pCi/g which is below criteria, 6.20 pCi/g.

URANIUM-238

PARAMETER	LOCATION	CONCENTRATION	DETECTION_LIMIT	UNITS
URANIUM-238	SC-39002-S	1.4	2.8	pCi/g
URANIUM-238	SC-39003-S	2.26	2.29	pCi/g
URANIUM-238	SC-39005-S	3.11	2.23	pCi/g
URANIUM-238	SC-39006-S	1.48	2.95	pCi/g
URANIUM-238	SC-39007-S	1.16	2.31	pCi/g
URANIUM-238	SC-39008-S	5.22	2.39	pCi/g
URANIUM-238	SC-39009-C	1.15	2.29	pCi/g
URANIUM-238	SC-39010-S	1.10	2.29	pCi/g
URANIUM-238	SC-39011-S	2.64	2.29	pCi/g
URANIUM-238	SC-39012-S	1.29	2.58	pCi/g
URANIUM-238	SC-39013-C	1.24	2.48	pCi/g

NUMBER OF URANIUM-238 SAMPLES IN DATABASE FOR THIS CU IS: 11

Average of URANIUM-238 values is 2.00 pCi/g, which is below ALARA, 30.00 pCi/g.

Maximum single value is 5.22 pCi/g which is below criteria, 120.00 pCi/g.

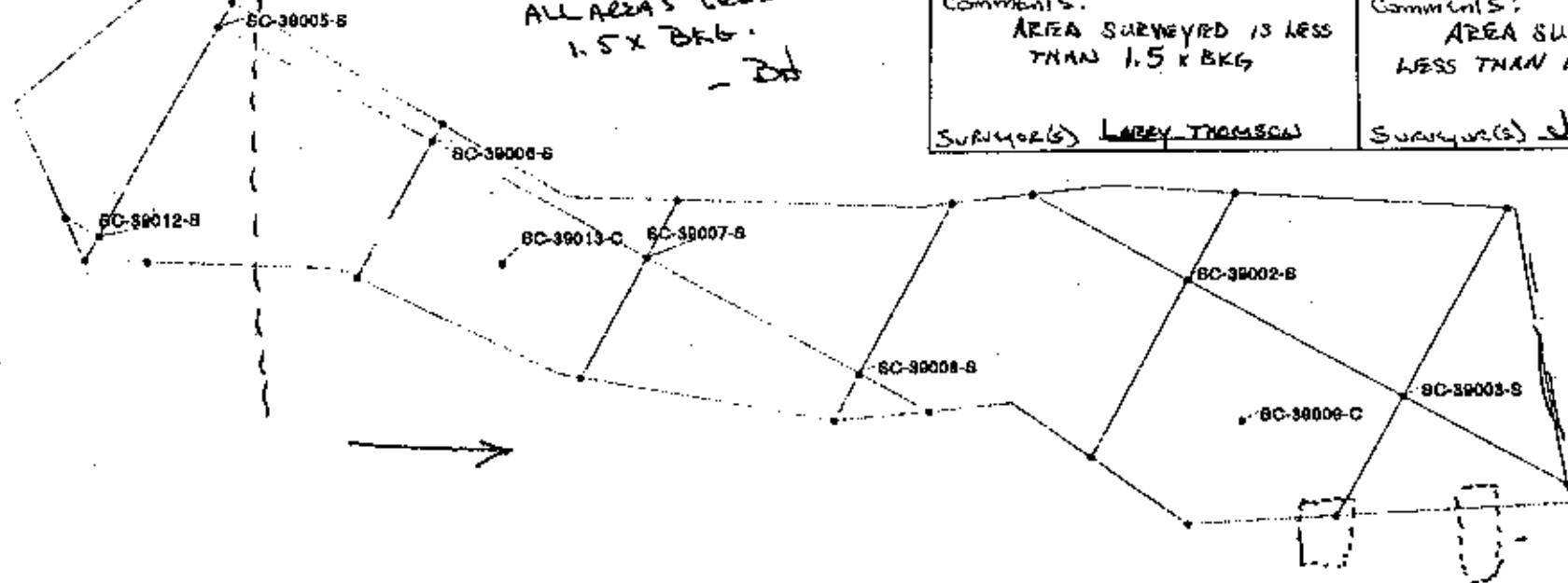
APPENDIX B
Radiation Field Survey Sheets

FPO

NOT
SURVEYED
AS OF 9-1-99

SURVEYED
AS 9-1-99
ALL AREA'S LESS THAN
1.5 X BKG.
- JH

Location - walls 44-9# - <u>J-10</u> Survey DATE - <u>9-1-99</u> Field BKG - <u>60</u> Limit <u>90</u> Comments: AREA SURVEYED IS LESS THAN 1.5 X BKG. Surveyor(s) <u>LARRY THOMSON</u>	Location - Floor 2x2# - <u>N</u> Survey DATE - <u>9-1-99</u> Field BKG - <u>4500</u> Limit <u>6750</u> Comments: AREA SURVEYED IS LESS THAN 1.5 X BKG. Surveyor(s) <u>JOHN MICHAEL</u>
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Sample Locations in Remedial Unit RU027 Confirmation Unit CU390		
Figure: 3-2		
EXHIBIT NO.: <u>G/CP/0177/0499</u>	REPORT NO.: <u>DOE/OR/21548-779</u>	
ORIGINATOR: <u>EJD</u>	DRAWN BY: <u>WSSRAP GIS</u>	DATE: <u>04/04/99</u>

All areas less than (within)
1.5 x Bkg.

surveyed as
of 09-07-99

FPO

↑
N

Location - walls
H4-G# - "C3" 5/N:094688
Survey DATE - 09-07-99
FIELD Bkg - 60cpm
Limit - 90cpm

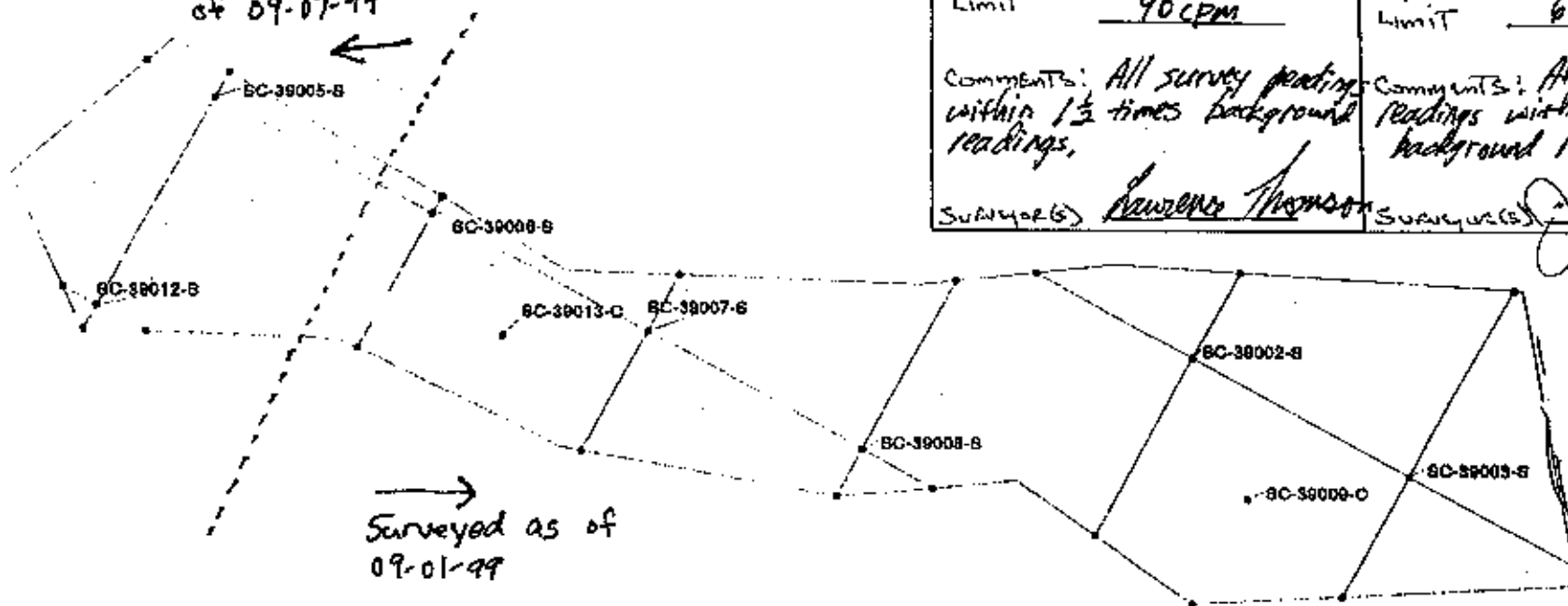
Location - Floor
ZX2# - "N" 5/N:130774
Survey DATE - 09-07-99
FIELD Bkg - 4000cpm
Limit - 6000cpm

Comments: All survey readings
within 1 1/2 times background
readings.

Comments: All Survey
readings within 1 1/2 times
background readings.

SURVEYOR(S) Lawrence Thompson

SURVEYOR(S) Janice R. J.



15 7.5 0 METERS

45 22.5 0 FEET

Sample Locations in Remedial Unit RU027 Confirmation Unit CU390

Figure: 3-2

EXHIBIT NO.: G/CP/0177/0499	REPORT NO.: DOE/OR/21548-779
ORIGINATOR: EJD	DRAWN BY: WSSRAP GIS DATE: 04/04/99

APPENDIX C
Analytical Data

NOTE: Values reported below the detection limit are shown in parentheses.

WP519/505F Confirmation Results

WSSRAP_ID	DATE_SAM	CONC	PARAMETER	DL	UNITS
SC-39002-S	09/01/1999	0.78	THORIUM-230	0.64	PCI/G
SC-39002-S	09/01/1999	ND	URANIUM-238	2.80	PCI/G
SC-39003-S	09/01/1999	1.00	THORIUM-230	0.64	PCI/G
SC-39003-S	09/01/1999	(2.26)	URANIUM-238	2.29	PCI/G
SC-39005-S	09/08/1999	0.87	THORIUM-230	0.62	PCI/G
SC-39005-S	09/08/1999	3.11	URANIUM-238	2.23	PCI/G
SC-39006-S	09/01/1999	1.14	THORIUM-230	0.65	PCI/G
SC-39006-S	09/01/1999	ND	URANIUM-238	2.95	PCI/G
SC-39007-S	09/01/1999	0.86	THORIUM-230	0.64	PCI/G
SC-39007-S	09/01/1999	ND	URANIUM-238	2.31	PCI/G
SC-39008-S	09/01/1999	1.00	THORIUM-230	0.65	PCI/G
SC-39008-S	09/01/1999	5.22	URANIUM-238	2.38	PCI/G
SC-39009-C	09/01/1999	0.95	THORIUM-230	0.65	PCI/G
SC-39009-C	09/01/1999	ND	URANIUM-238	2.29	PCI/G
SC-39010-S	09/01/1999	0.93	THORIUM-230	0.64	PCI/G
SC-39010-S	09/01/1999	ND	URANIUM-238	2.19	PCI/G
SC-39011-S	09/08/1999	0.94	THORIUM-230	0.62	PCI/G
SC-39011-S	09/08/1999	(2.84)	URANIUM-238	3.09	PCI/G
SC-39012-S	09/08/1999	0.78	THORIUM-230	0.62	PCI/G
SC-39012-S	09/08/1999	ND	URANIUM-238	2.58	PCI/G
SC-39013-C	09/01/1999	0.89	THORIUM-230	0.64	PCI/G
SC-39013-C	09/01/1999	ND	URANIUM-238	2.48	PCI/G

Row Filter: DATE_SAM between #08/01/99# AND #12/31/99# (Marked Rows Only)

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Weldon Spring Site Remedial Action Project

CU390 Coordinate List

<u>Northing</u>	<u>Easting</u>	<u>Elevation</u>	<u>Sample ID</u>
1045575.25	755217.61	583.54	SC-39002-S
1045559.23	755246.28	583.23	SC-39003-S
1045610.86	755087.12	580.82	SC-39005-S
1045594.69	755115.84	584.32	SC-39006-S
1045578.68	755144.44	583.91	SC-39007-S
1045562.66	755173.04	583.43	SC-39008-S
1045556.05	755224.65	582.49	SC-39009-C
1045535.06	755232.76	583.30	SC-39010-S
1045582.07	755071.09	581.76	SC-39012-S
1045577.92	755124.89	582.37	SC-39013-C

APPENDIX D
QA/QC Analytical Data

WP519/505F Confirmation Results - QC

WSSRAP_ID	DATE_SAM	PARAMETER	CONC	DL	UNITS
SC-39005-S-DU	09/08/1999	THORIUM-230	0.96	0.64	PCI/G
SC-39005-S-DU	09/08/1999	URANIUM-238	4.01	2.14	PCI/G
SC-39005-S-FR	09/08/1999	THORIUM-230	0.91	0.64	PCI/G
SC-39005-S-FR	09/08/1999	URANIUM-238	6.07	2.48	PCI/G
SC-39005-S-SD	09/08/1999	THORIUM-230	1.67	0.117	PCI/G
SC-39005-S-SD	09/08/1999	URANIUM-238	3.66	2.47	PCI/G

Row Filter: DATE_SAM between #08/01/99# AND #12/31/99# (Marked Rows Only)

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Weldon Spring Site Remedial Action Project